Fishery Data Series No. 05-44

Salmon Enumeration in the Nome River Using Video Technology, 2004

Annual Report for Project 05-06, *Salmon Enumeration in the Nome River Using Video Technology*
Norton Sound Salmon Research and Restoration Program
Fishery Disaster Relief Program for Norton Sound, Alaska

by

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and

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August 2005

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 05-44

SALMON ENUMERATION IN THE NOME RIVER USING VIDEO TECHNOLOGY, 2004

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ABSTRACT

Video recording equipment was installed at the Nome River weir during 2004 to enumerate and identify fish species passing through the weir. Problems encountered during the season prevented complete enumeration of all species and full assessment of this technology. A flood event washed the weir out from 8–19 August. The video equipment was operational on 28 July, and fish passage was recorded intermittently through 3 September. Accuracy of video enumeration was evaluated by comparing recorded video files (fish counts by species) with counts made by fishery technicians at the weir. The reliability of the video equipment was evaluated by the number and frequency of equipment failures or problems. There were 22 video recordings were randomly subsampled from 60 recordings to determine accuracy. The overall accuracy of video technology used to count the total number of pink *Oncorhynchus gorbuscha*, chum *O. keta*, and coho *O. kisutch* salmon passage was 99%. The accuracy of video technology to identify the species of passed fish was 102% for pink salmon, 86% for coho salmon, and 11% for chum salmon. Variation in the accuracy of species identification is likely the result of several factors. The primary factor was the initial set up of the camera angle, looking straight down over the water, which did not provide an optimal lateral (side) view for identifying fish species. Other factors were the magnitude of the pink salmon run (> 1,000,000 fish) and observer inexperience in distinguishing between characteristics of individual species. No technical difficulties were encountered with the recording, transmission, and storage of video data. However, technical difficulties were encountered with counting and filtering software. Accuracy of identifying fish to species can be improved by monitoring systems where salmon escapements are less numerous, using an oblique camera angle, and training observers to recognize distinguishing characteristics of individual species.

Key words: Norton Sound, Nome Subdistrict, Nome River, video monitoring technology, chum salmon, *Oncorhynchus keta*, pink salmon, *O. gorbuscha*, coho salmon, *O. kisutch*, abundance, run timing.

INTRODUCTION

Accurate and timely abundance and run timing information is required by fisheries managers to effectively manage salmon resources inseason. Ground based escapement monitoring projects provide managers with the most accurate and timely inseason information. In the Norton Sound Area, ground based monitoring projects have been established on a limited number of systems largely because of high operating costs of remote projects, logistical needs, and staffing costs. For river systems without ground based monitoring projects, inseason aerial surveys provide managers with abundance estimates. Use of aerial surveys to monitor salmon abundance is costly and can be unreliable because of poor weather, aircraft and pilot availability, or large runs of one species making enumeration of other species difficult (e.g. even year pink salmon). Aerial surveys serve only as indices of escapement, not actual escapement estimates. Video technology can provide a more cost effective means of monitoring salmon escapement compared to current monitoring methods. Employing video technology can decrease the high costs associated with ground based monitoring projects and problems associated with aerial surveys, subsequently allowing additional systems to be monitored with current funding levels. Increasing the number of systems monitored in the Norton Sound Area would increase the ability of managers to effectively manage the salmon resources within guidelines established by the State of Alaska's Policy for the Management of Sustainable Salmon Fisheries and the Alaska Board of Fisheries.

The Nome River drainage is approximately 50 km long, and enters into Norton Sound 5 km east of the city of Nome (Figure 1). Chinook salmon *Oncorhynchus tshawytscha*, sockeye salmon *O. nerka*, chum salmon *O. keta*, coho salmon *O. kisutch*, and pink salmon *O. gorbuscha* stocks spawn in the Nome River drainage. Much of Nome River is accessible by road and Nome residents recreate along the river and at the mouth. Residents subsistence fish in the Tier II chum salmon subsistence fishery and sport and subsistence fisheries for coho and pink salmon take place in the lower sections. A Tier II chum salmon subsistence fishery occurs in the lower 2 km of Nome River if the Alaska Department of Fish and Game (ADF&G) determines minimum escapement needs will be achieved. The current weir location is approximately 5 km up river from the mouth (Figure 2).

Ground based enumeration of salmon returns to Nome River began in 1993 with a counting tower (Rob 1995). In 1996, the tower was replaced with a picket weir. Low total seasonal escapement and low fish passage rates are common for all species except pink salmon during even years. Chum salmon escapements since 1993 have ranged from 1,048 to 5,147 fish and the recent 5-year average (1999–2003) is 2,328 fish (Table 1). Pink salmon escapements in even years (1994–2002) have ranged from 41,673 to 359,469 fish, averaging 134,897 fish. Pink salmon escapements during odd years (1993–2003) have ranged from 2,033 to 13,893 fish, averaging 8,590 fish. Coho salmon escapements since 1993 have ranged from 66 to 4,349 fish and the recent 5-year average (1999–2003) is 1,499 fish. Peak daily chum salmon passage counts have ranged from 127 to 638 fish, and coho salmon peak daily counts have ranged from 23 to 1,156 fish.

The use of video technology to monitor salmon escapement has been examined by many researchers (Hatch et al. 1994; 1998; Irvine et al. 1991) and is currently being tested and used in several areas in the state of Alaska for monitoring salmon escapements (Hetrick et al. 2003; Otis 2000; Otis and Dickson 2002). In 2004, video technology was installed on the Nome River and evaluated for accuracy and reliability.

OBJECTIVES

The primary project objectives in 2004 were to:

1. Enumerate salmon escapements by species in Nome River using video technology.
2. Determine the accuracy and reliability of video monitoring techniques by comparing video enumeration with actual weir counts.
3. Determine run timing and passage rates for chum, pink, and coho salmon.
4. Allow salmon migrations to occur normally without impeding or delaying, as is common when enumerating coho salmon through a weir.

A secondary objective was to assess cost effectiveness of video enumeration compared to costs of tower or weir enumeration.

METHODS

OPERATIONS

This project was operated concurrently with the Nome River weir project. The weir is 60 m wide, and is constructed of metal pickets with aluminum stringers (Kohler and Knuepfer 2002). Pickets are removed to pass and enumerate fish. A live-box installed on the downriver side of the weir was used to sample and pass fish. Project crew members enumerate fish passage through the weir by opening a gate or pulling several weir pickets and counting fish as they migrate through the opening. Passage counts occurred regularly throughout the day, typically for 1–2 hour periods, beginning early morning and continuing into late evening, as ambient light permitted. Video recordings were made concurrently with weir counts. When personnel passed fish, the video system was turned on, starting the recording software. Weir crew members then passed a marker in front of the camera before passing any fish and again when they finished to indicate counting periods. All fish passage for concurrent counts was done through the front of the live-box where the overhead camera recorded. Initially, recordings were made on a daily basis alternating between the overhead and underwater camera. Switching between the cameras from the Nome office was possible using a motherboard specially designed by SeeMoreWildlife, Inc. of Homer, Alaska.[1] Yagi 7-element antennas were placed at each site with a total of 2 at the repeater site (a combination of receive and transmit equipment) to relay camera information between the Nome office and the weir site. Alternating between cameras was used to determine which camera provided the optimal view to count and identify fish to species. After several days, the overhead camera was used exclusively as it provided the best recording for counting fish (the underwater camera provided the best view for identifying fish).

A 4 m tall tripod was set up immediately upstream of the weir live-box and approximately 4.5 m from the east river bank. An overhead camera was mounted below the tripod platform and aimed straight down to cover the area in front of the live-box (Figure 3). A second waterproof camera was installed underwater on a metal pipe and aimed horizontally in front of the live-box (Figure 3). Both cameras were manufactured by Applied Microvideo, Inc. of Sunnyvale, CA. A white flash panel placed on the river bottom immediately in front of the live-box provided a contrasting background. Video clips were recoded on site to an external 60 GB mobile hard drive, connected through a 1 GB desktop computer. ViewPort™ control software from SeeMore Wildlife Inc., allowed video recording parameters to be user defined. All computer equipment was housed in a 3 m by 2 m shed. All equipment (computer, cameras, repeater/receiver) at the weir site was powered by 2 battery banks (each consisting of 3 marine deep discharge 12-V batteries) and 6 solar panels 85-W with charge controllers to charge the batteries. Power was supplied from an established Federal Aviation Administration (FAA) site at the Newton repeater.

Live video from the weir was also transmitted to the Nome office via a microwave transmission system. To transmit the video and control which camera was transmitted, along with checking equipment voltages remotely from the Nome office, a repeater site was established on Newton Peak because there is no direct line of site between the weir and the office (Figure 2). The transmission/receiver equipment installed at each site (weir, repeater, and office) consisted of a microwave transmitter/receiver (Premier BE-322R, 2.4 GHz by Premier Wireless Inc. of Antioch, CA.) and a parabolic wire dish (California Amplifier Large Wire Dish with 24 db QLP Parabolic Antenna feed by California Amplifier of Oxnard, CA). At the repeater site 2 transmitter/receiver systems were installed: one to receive transmissions from the weir site, another to transmit to the Nome office. Switching between the cameras from the Nome office was possible using the specially designed motherboard. Yagi 7-element antennas were placed at each site (2 at the repeater site) to relay camera information between the office and the weir site.

Video records were downloaded frequently and returned to the Nome office, the external hard drive was swapped out and brought back to the office for filtering/enumeration. Fish passage was then enumerated using time-lapse recording (filtering) and counting software from SeeMore Wildlife, Inc. Transmitted video was stored on a computer located in the Nome office with the video camera control software installed.

[1] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

ACCURACY

To assess the accuracy of the video system's ability to enumerate and identify fish to species, it was assumed that salmon escapement counts from the weir accurately reflected actual escapements. Salmon escapement counts obtained from the video system were calculated as percentages of the weir counts to provide a quantitative assessment of accuracy. Enumeration counts within species were also compared in the same manner to determine the accuracy of the video system in identifying fish to species. Although 60 video records were made, 22 randomly subsampled video records were reviewed to determine accuracy. In addition, post hoc analyses of the effects of varying light (cloudy, low-light, sunny) and water surface conditions (glare, chop, calm, rain) on accuracy were attempted.

RELIABILITY

The reliability of the video equipment was evaluated by the number and frequency of equipment failures, the amount of time needed for problems to be detected and assessed, and effort needed to fix those problems.

RESULTS

OPERATIONS

Installation of the video system began on 20 July and was operational from 28 July through 3 September (Table 2). The start up date for the project was delayed by nearly 2 weeks because of difficulties in procuring video equipment. No video counts were made on 1 August, 4 August, 7-29 August, or 1 September (Table 2). A flood event washed the weir out from 8 August through 19 August. The weir was repositioned upstream of the previous location and became operational on 19 August. However, from 19–30 August, no video recordings were made because high water levels prevented crew members from reinstalling the video system upstream of the weir. Prior to the flood, staff determined the overhead (down looking) camera needed to be moved and the view angle changed to oblique to allow partial lateral view for better fish identification. However, a flood event prevented crews from moving the camera and changing the angle.

ACCURACY

The overall accuracy of video technology to count the total number of fish passed was 99% (Table 3). The overall accuracy of video technology in identifying target species were: pink salmon 102%, coho salmon 86%, and chum salmon 11% (Table 3). Of the 22 subsampled video recordings, 15 were recorded under overcast conditions, 3 under low light conditions, and 3 under sunny condition. Of these, 15 were with calm surface conditions, 7 with waves associated with wind, and 1 with surface glare. There were no apparent effects on the overall accuracy of total fish counts or identifying fish species as the result of varying light and surface conditions. However, samples sizes within the light and surface condition groups were uneven and small, making thorough and conclusive analyses impossible.

RELIABILITY

There were no technical difficulties with the operation of the recording, transmission, and storage of video data. Technical difficulties were encountered with the counting and filtering software on several occasions, and considerable time was needed to correct these problems.

DISCUSSION

Administrative problems with funding resulted in a delay in the procurement and installation of the video equipment. A substantial percentage of the total chum and pink salmon escapements passed the weir prior to full operation of the video equipment. As a result, the project was not able to achieve the objective of determining run timing and passage rates for these species. In addition, the high water level at the weir resulted in no video recordings for most of August. The project was not able to achieve the objective of determining run timing and passage rates for coho salmon. If the system was accurate (near identical video recorded counts and personnel enumeration), the plan was to open the weir and count a portion of the coho salmon run using the video system only. The onsite video desktop computer would not run the filter/enumeration software and allow recording to occur at the same time, so all review was conducted in the office, further delaying system testing and full operations. Consultations were made with Ted Otis (Commercial Fisheries Biologist, ADF&G, Homer) who has been operating video monitoring equipment on several systems for approximately 5 years. Mr. Otis' travel to the project for consultation was delayed further because of the late start. Mr. Otis likely would have been able to identify some problems earlier.

The video equipment was nearly as accurate at counting total fish passage as staff enumeration through the weir. The high variation between the accuracies in identifying chum, coho, and pink salmon is likely the result of several factors. The primary factor was the initial set up of the camera angle, looking straight down into the water. Video recorded from this angle did not provide an optimal view for identifying fish to species because the lateral view (sides) of fish were not visible. Other factors were the magnitude of the pink salmon run (> 1,000,000 fish and largest on record) and observer inexperience in identifying species characteristics. Accuracy can be improved by setting up the overhead camera at an oblique angle to the river surface. This would provide a better lateral view, thereby improving identification. Identification can also be improved by monitoring smaller systems where total salmon escapements, particularly even year pink salmon, are less numerous. Finally, observers can be further trained to recognize distinguishing characteristics between species, such as external markings, behavior, and size.

In the short time the video system operated, there were no technical problems with the operation of the video equipment. The system was able to record, store, and transmit data to the Nome office successfully. Technical difficulties were experienced with the filtering and counting software throughout the season, and considerable time was spent dealing with the software developers to correct. When problems were encountered, the vendor, SeeMoreWildlife, Inc., sent software patches for corrections and also made software modifications based on suggestions made to make the software more user friendly and allow us to set specific criteria when filtering. Adjustments made to the camera angle to improve the video quality (improving our ability to identify fish to species) occurred after high water levels and heavy carcass loading caused the weir to become inoperable, hindering our ability to fully assess results of the new camera angle.

ACKNOWLEDGEMENTS

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REFERENCES CITED

Hatch, D. R., J. K. Fryer, M. Schwartzberg, and D. R. Pederson. 1998. A computerized editing system for video monitoring of fish passage. North American Journal of Fisheries Management 18:694-699.

Hatch, D. R., M. Schwartzberg, and P. R. Mundy. 1994. Estimation of Pacific Salmon Escapement with a time-lapse video recording technique. North American Journal of Fisheries Management 14:626-635.

Hetrick, N., K. M. Simms, M. P. Plumb, and J. P. Larson. 2003. Feasibility of using video technology to estimate salmon escapement in the Ongivinuk River, a clear-water tributary of the Togiak River. U.S. Fish and Wildlife Service, King Salmon Fish and Wildlife Field Office, Alaska Fisheries Technical Report Number 72, King Salmon Alaska.

Irvine, J. R., B. R. Ward, P. A. Teti, and N. B. F. Cousens. 1991. Evaluation of a method to count and measure live salmonids in the field with a video camera and computer. North American Journal of Fisheries Management 11:20-26.

Kohler, T., and G. Knuepfer. 2002. Nome River salmon counting weir project, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A02-13, Anchorage.

Otis, T. 2000. Design and operation of a remote video escapement recorder (RVER) for counting salmon in small clear streams. American Fisheries Society Conference, Alaska Chapter, 2000, Fairbanks.

Otis, T. and M. Dickson. 2002. Improved salmon escapement enumeration using remote video and time-lapse recording technology, Exxon Valdez Oil Spill Restoration Project Final Report (Restoration Project 00366). Alaska Department of Fish and Game, Division of Commercial Fisheries, Homer.

Rob, P. 1995. Nome River counting tower project summary report, 1995. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report 3A95-26, Anchorage.

TABLES AND FIGURES

Table 1.–Annual chum, coho and even and odd-year pink salmon escapements, Nome River escapement project, 1993–2003.

Year	Chum	Coho	Pink (even-year)	Pink (odd-year)
1993	1,859	4,349		13,036
1994	2,969	726	142,604	
1995	5,093	1,650		13,893
1996	3,339	66	95,681	
1997	5,147	321		8,035
1998	1,930	96	359,469	
1999	1,048	417		2,033
2000	4,056	696	41,673	
2001	2,859	2,418		3,138
2002	1,720	3,418	35,057	
2003	1,957	548		11,402
1993–2003 Historical Average	2,907	1,337	134,897	8,590

Table 2.–Daily fish passage at Nome River weir with corresponding counts from the video system, 2004.

					Weir Counts							Video Counts						
	Time									Dolly	Weir						Dolly	Video
Date	Start	Stop	Light [a]	Surface [b]	Sockeye	Chinook	Chum	Pink	Coho	Varden	Total	Sockeye	Chinook	Chum	Pink	Coho	Varden	Total
07/29	16:00	17:28	s	c	0	0	0	147	0	18	165	0	0	0	178	0	14	192
07/30	11:15	12:15	o	c	0	0	2	871	14	15	902	2	0	0	946	4	31	983
07/31	06:30	07:22	o	c-w	0	1	14	515	1	10	541	1	0	3	516	0	15	535
07/31	19:34	20:23	o	w	0	1	14	2,442	10	8	2,475	0	1	2	2,262	0	5	2,270
07/31	22:08	22:44	o	w-c	0	0	0	1,106	5	10	1,121	0	0	0	1,047	0	4	1,051
08/02	16:23	17:33	o	c	3	1	6	2,406	5	40	2,461	7	0	4	2,243	1	56	2,311
08/02	19:17	19:54	o	c	0	0	7	746	2	11	766	8	0	2	750	0	11	771
08/02	21:22	21:45	o	c	0	0	7	912	5	27	951	7	0	0	925	0	26	958
08/02	23:08	23:38	o	c	0	0	1	651	2	58	712	1	0	0	711	0	40	752
08/03	06:50	07:41	o	w	1	0	12	1,502	1	58	1,574	5	0	2	1,533	0	54	1,594
08/03	13:16	14:02	o	w	0	0	11	1,022	6	19	1,058	0	0	0	1,035	13	35	1,083
08/03	16:20	17:02	s-o	c-g-w	1	2	33	2,480	35	62	2,613	54	2	0	2,453	0	6	2,515
08/03	18:23	19:31	o	g-w	0	0	19	4,341	9	79	4,448	1	0	0	4,352	9	17	4,379
08/05	20:28	22:29	s	c	1	0	19	3,232	50	485	3,787	0	0	0	3,572	59	287	3,918
08/06	06:53	07:28	s	c	1	0	11	477	10	37	536	14	0	0	504	0	5	523
08/06	17:52	18:37	o	c	1	0	19	2,040	12	147	2,219	7	0	5	2,186	13	138	2,349
08/06	21:43	22:40	o	c	1	0	16	2,461	29	159	2,666	2	0	5	2,767	21	0	2,795
08/06	23:23	23:59	o	c	0	0	2	421	2	119	544	0	0	0	317	5	122	444
08/30	17:07	18:10	o	w	0	0	0	7	1	1	9	0	0	0	5	2	0	7
08/31	21:42	23:11	l-o	c	0	0	5	110	50	34	199	0	0	0	68	78	48	194
09/02	07:41	08:45	l	c	0	0	1	5	1	3	10	0	0	0	0	5	2	7
09/03	21:00	22:48	l-c	w	1	0	3	59	15	2 0	98	0	0	0	55	17	9	81
Total Counts					10	5	202	27,953	265	1,420	29,855	109	3	23	28,425	227	925	29,712

[a] o = overcast, s = sunny, and l = lowlight.

[b] c = calm, w = waves, and g = glare.

Table 3.–Video system enumeration and speciation accuracy, 2004.

Species	Accuracy	Video Count	Manual Count
pink salmon	102%	28,425	27,953
coho salmon	86%	227	265
chum salmon	11%	23	202
Total	99%[a]	28,203	28,420[a]

[a] A total pink salmon count of 27,953 was used to determine total accuracy.

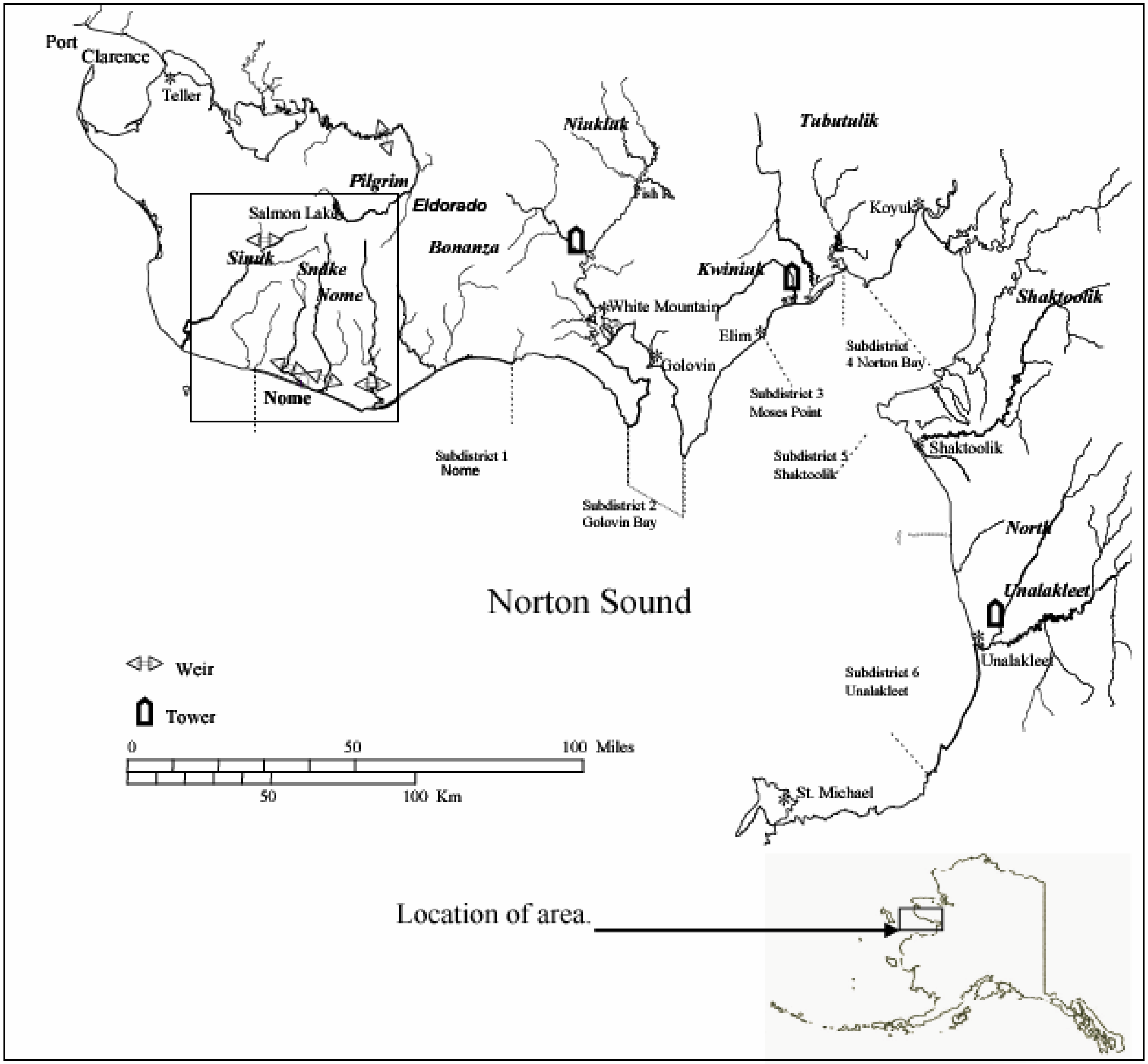

Figure 1.–Northern Norton Sound Area showing locations of Nome River and other fish enumeration project sites.

Figure 2.–Lower Nome River showing location of the weir and repeater sites.

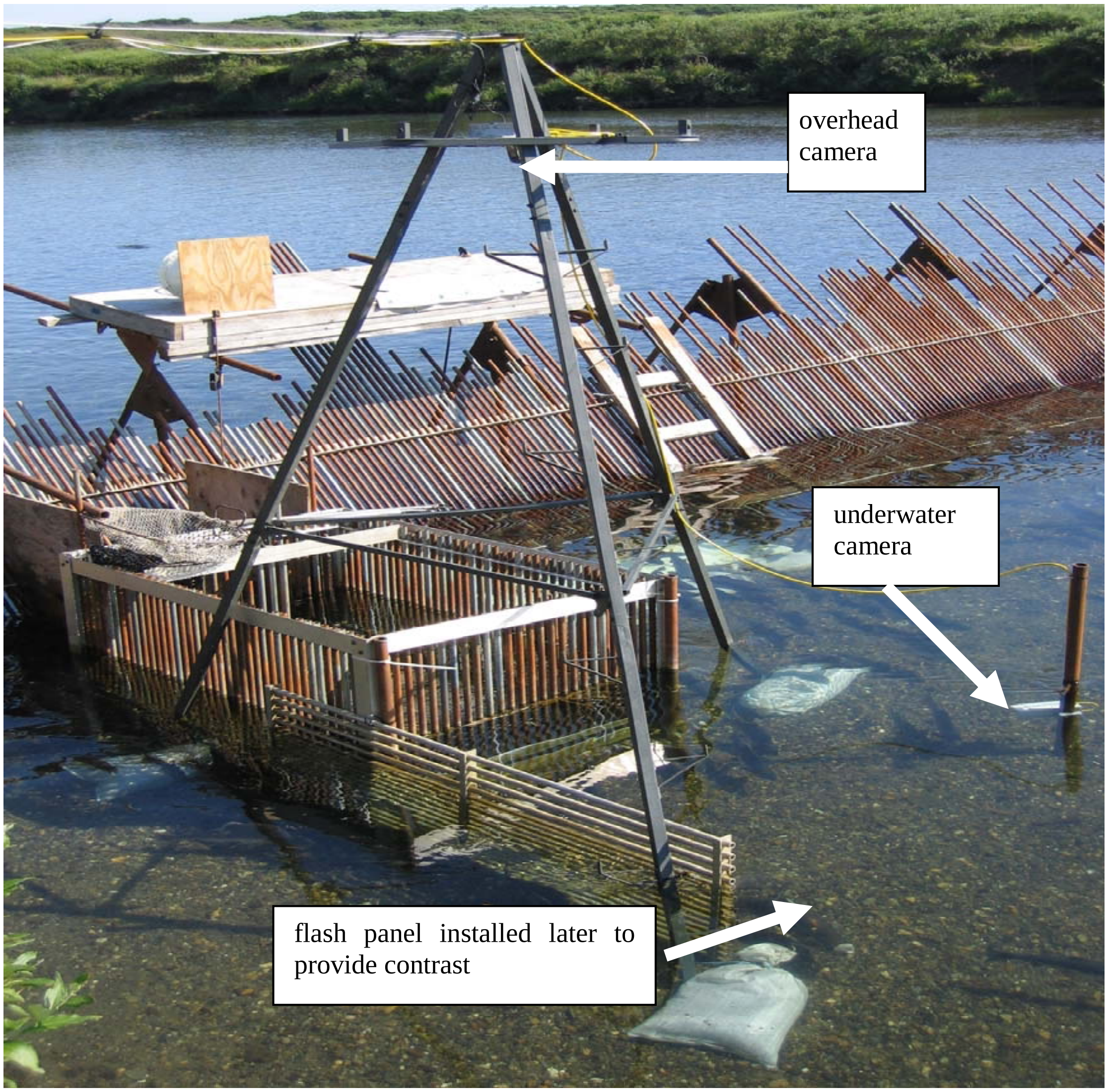

Figure 3.–Set-up of tripod and cameras.